DOCUMENT RESUME

ED 465 333 HE 034 983

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TITLE Predicting Academic Performance and Retention of Private University Freshmen in Need of Developmental Education.

PUB DATE 2002-04-00

NOTE 22p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 1-5, 2002).

PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS *Academic Achievement; College Entrance Examinations; *College Freshmen; *Developmental Programs; Grade Point Average; High School Students; Higher Education; *Prediction; Private Colleges; *School Holding Power; Scores; Sex Differences

ABSTRACT

This study examined the academic success and retention of first-year college students at a small private university to determine which variables (among the following: gender, high school grade point average (GPA), Scholastic Assessment Test (SAT) verbal and quantitative scores, and indicators of placement into developmental courses) were predictive of three outcomes: (1) academic achievement during the freshman year; (2) retention to the second year; and (3) the combination of retention and university GPA greater than or equal to 2.5. Results for 666 students in 3 years confirm the findings of other studies, in which GPA at the end of the first year is associated with gender, high school GPA, and verbal and quantitative SAT scores; however, the type of skills development needed by the student--a course in reading, writing or mathematics--was not predictive of academic achievement or retention. These findings are discussed in light of the developmental program offered at the institution. (Contains 1 figure, 4 tables, and 22 references.) (SLD)

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Predicting Academic Performance and Retention of Private University Freshmen in Need of Developmental Education

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Paper Presented at the Annual Meeting of the

American Educational Research Association

April, 2002

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Abstract

The study examined the academic success and retention of first-year college students at a small private university to determine which variables (among the following set—gender, high school GPA, SAT verbal and quantitative scores, and indicators of placement into developmental courses) were predictive of three outcomes: (1) academic achievement during the freshman year, (2) retention to the second year, and (3) the combination of retention and university GPA ≥2.5. Results confirm the findings of other studies, where GPA at the end of the first year is associated with gender, high school GPA, and verbal and quantitative SAT scores. However, the type of skills development needed by the student—a course in reading, writing, and/or mathematics—was not predictive of academic achievement nor retention. These findings are discussed in light of the developmental program offered at the institution.

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PREDICTING THE ACADEMIC PERFORMANCE AND RETENTION OF UNIVERSITY FRESHMEN IN NEED OF DEVELOPMENTAL EDUCATION

Introduction

Purpose and Rationale

This study looked at the academic achievement and retention of university freshmen in need of developmental education (i.e., those who test into one or more developmental courses). The university (a small—4,000 students, private, liberal arts, California school) shares a goal with most postsecondary education institutions, i.e., that of improving retention, especially as indicated by the return of freshman students as sophomores.

Predictors readily available to admissions officers at institutions have included the student's gender, prior educational performance, and scholastic aptitude test scores. The predictability of high school grades has long been known (Astin, 1993; Astin, Tsui, & Avalos, 1996; Gallicki & McEwen, 1989; Lewallen, 1993; Daly & Breegle, 1989; and York, Bollar, & Schoob, 1993).

Once students are admitted to the university where the current study took place, they take basic skills proficiency tests in reading, writing, and quantitative (mathematics) skills during orientation prior to the first day of class. Based on testing, these developmental students are required to take one to three developmental education courses. Clifford Adelman, of the U. S. Department of Education, has examined data from the college transcripts of a sample of 1982 high school graduates, with follow-up surveys through 1993. Adelman reports that, of this group, the students who took the greater number of developmental courses had lower rates of bachelor's-degree completion. He also found that students who entered college needing

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developmental work in reading were more likely to fail than those who required work in mathematics or writing (Adelman, 1996, p. A56).

In this study we investigated whether a reasonably accurate prediction model can be developed for use with the developmental student population (i.e., that population of freshman students placing into one or more of the developmental education courses) that is based only on information gathered prior to admission. We also tested whether knowing the type of developmental education needed (whether reading, writing, or math) improved the prediction. The aim was to develop a model for the classification of future students and to determine the accuracy of the model's prediction using a cross-validation sample of similar university students who required developmental education courses. One use of this model would be to identify developmental students who were not predicted to be successful, even given the opportunity for academic support, and encourage their utilization of services.

The purpose of the current study was to determine, for developmental students, which of a set of variables were predictive of three outcomes: (1) academic achievement during the freshman year, (2) retention to the second year, and (3) a combination of retention and GPA > 2.5. Moreover, the aim was to develop a model for the classification of future students and to determine the accuracy of the model's prediction using a cross-validation sample of similar university students who required developmental education courses.

Method

Sample

The population consisted of freshmen admitted to a small, private university whose performance on basic skills tests taken during orientation (after students' admission to the university) indicated a need for developmental education. Based on testing, these developmental

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students are required to take one to three developmental education courses. International students and students allowed to defer enrollment in what would otherwise be a required sequence of freshmen courses at our university (known as "Mentor" classes) were excluded from the sample. Deferrals to the Mentor classes are on the basis of extremely low reading and/or writing scores (typically so that students can enroll in ESL courses before their developmental reading and/or writing courses). Thus Mentor-deferred students are not enrolled in the same curriculum as other freshmen at the institution.

The population for which records were accessible includes developmental students at the university (who were neither international nor Mentor-deferred students) who matriculated during the Fall semesters of 1995 (n= 260), 1996 (n= 162), and 1997 (n= 244). Thus, the sample available for use in the data analysis consisted of 666 students.

The sample was predominately female (59.8%), and most of the students (80.3%) enrolled the following Fall Semester (i.e., cases we classified as "retained"). The proportion of students in the sample who were required to take developmental courses follow: Reading- 26.6%; Writing- 70.6%; and Math- 47.1%. Descriptive statistics for the sample's high school grade point average, university grade point average, and SAT scores are shown in Table 1.

Developmental Course Placement

All students who are admitted to the University are administered basic skills tests during the summer Freshman Orientation sessions, prior to their matriculation Fall semester. Placement into the developmental reading course is based on a total raw score of 91 or below on the Nelson Denny Reading Test, Form G (Brown, Fishco, & Hanna, 1993). Placement into the appropriate developmental math course based on scores achieved from taking one or more tests from The Descriptive Tests of Mathematics Skills of the College Board (Educational Testing Service,

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1979). And placement into the appropriate writing course was based on a score achieved by a locally-developed, holistically-scored writing sample, read by two readers (or a third reader in the case of disparate scores).

Variables

The seven predictor variables included students' gender (1= female, 0= male); high school grade point average (HSGPA), SAT college entrance exam scores (Verbal: VSAT; Quantitative: MSAT), and whether the student was required to take developmental reading, writing, or mathematics (1= developmental course required, and 0= no developmental course for READING, WRITING, MATH). Criterion variables included students' university grade point average (U-GPA) after two semesters, retention status (RETAINED: 1=enrolled the following Fall Semester, 0=not enrolled), and a combination (GPAOKRET) of these (1=retained with a 2.5 U-GPA or better, 0=not retained and/or U-GPA under 2.5).

Data Analysis Procedures

The database was created by combining archival information available from the university's Office of the Registrar and its developmental program, the Educational Resource Center. Once the records of the 666 cases in the sample were available, a sample of approximately 70% of the cases (N= 462) was randomly selected to use in the model building phase of the analysis. The remaining cases (N=204) were held out for use in the model validation phase. Listwise deletion of missing cases (i.e., where a case is removed if information on any one of the predictor or criterion variables is unavailable) was employed leaving 426 cases for the initial phase.

Pearson product-moment correlations were calculated for each predictor variable-criterion variable pair (see Table 2) and tests of statistical significance were employed using an

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alpha level of .01 (1-tail) to determine whether the two respective variables are related. As Glass and Hopkins (1996) explain, "The general formula for the Pearson *r* is applicable when either or both X and Y are ranks or dichotomous, but the resulting coefficients are denoted by special names. . . . When one variable is a dichotomy, the correlation is termed a point-biserial coefficient; if both variables are dichotomies, the correlation is a phi coefficient" (p. 140). These results are mathematically consistent with those obtained had *t*-tests for independent samples replaced testing of point-biserial coefficients and chi-square tests of association replaced testing of phi coefficients. See the appendix for a table of corresponding statistical tests.

Logistic regression was utilized to develop and test the prediction model. The final logistic regression that best fit the data included just two predictors. Because 19 of the 36 cases originally removed through listwise deletion with the full 7-predictor model were missing values only for predictors that did not become part of the final model, the latter reduced model is based on the 445 cases with valid values for GENDER, HSGPA, and GPAOKRET (the criterion). In the validation sample, 183 cases (of 204) had complete information and were used to check for shrinkage in the classification accuracy.

Results

Individual Predictors of Freshman Academic Achievement

Statistical significance testing of the correlations associated with the first outcome indicate that the university GPA's at the end of the freshman year are associated with gender, high school GPA, verbal SAT scores, and quantitative SAT scores. Knowing which of the basic skills tests the developmental student failed was not predictive of freshman GPA. (See the first column of numerical entries in Table 2, which shows the correlation coefficients between individual predictors and the three outcomes.)

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Individual Predictors of Freshman Retention

Statistical significance testing of the correlations associated with the second outcome indicate that high school GPA is the only predictor in this study that is associated with whether or not students enroll at the university for a second year (i.e., one year later in the Fall Semester). Neither gender, SAT scores, nor basic skills indicators were predictive of retention. (See the second column of Table 2.)

Individual Predictors of Freshman Retention with University GPA $\geq$ 2.5

Statistical significance testing of the correlations associated with the third outcome indicate that gender, high school GPA, and SAT quantitative scores are each associated with whether or not students enroll at the university for a second year (i.e., one year later in the Fall Semester) and have a university GPA of 2.5 or better. Neither verbal SAT scores, nor basic skills indicators were predictive of the combined outcome based on retention and academic performance. (See the third column of Table 2.)

Logistic Regression Model for Predicting Freshman Retention with University GPA $\geq$ 2.5

A model for predicting the probability that an incoming freshman would be retained for a second year and have achieved a GPA $\geq$ 2.5 his/her first year was developed using logistic regression. Students who met the criterion of being retained with a GPA $\geq$ 2.5 were coded 1 (referred to as "Group 1" below); students who either were not retained (by their own choice or by failing to meet university requirements) or who did not achieve a cumulative GPA during their freshman year of at least 2.5 were coded 0 (referred to as "Group 0" below). Coincidentally, when coupled with retention status, the cutpoint of 2.5 we assigned for separating students by GPA below and above 2.5 resulted in equal numbers of cases in each of the dichotomous groups, which together constitute the criterion being predicted. This is

fortunate, because, as Wright (1995) points out, having proportions of cases in each group that are approximately equal typically optimizes classification accuracy. We used a non-sequential logistic regression where all 7 predictors were initially included in the model. Based on the Wald test, however, only gender and high school GPA were found to be statistically significant. The deviance (-2*LL*) was 547.379. Although the model with these two predictors was an improvement over the base model which utilizes only a constant term [Model chi-square(2 df, N = 445) = 69.502, p< .001], the Nagelkerke R Square value of .193 is modest. Sensitivity (the proportion of Group 1 that was correctly classified) was 70.6%. Specificity (the proportion of Group 0 that was correctly classified) was 66.1%. The overall percentage of correctly classified cases (*PAC*) using gender and high school GPA as predictors was 68.3% which, although low, compares favorably to the base model's rate of 50.3% when no predictors are utilized.

The 2-predictor model is presented in Table 3. The model predicted that, when controlling for high school GPA, the odds of being retained with a GPA > 2.5 increase by a factor of 1.84 when the student is female (as compared to male). After controlling for gender, for every positive one unit of change in high school GPA (for example, a "3.3" versus a "2.3" GPA), the odds of being in the target group increase by a factor of 6.65. The two logistic curves (one for each gender) based on the model are shown in Figure 1 where it can be seen that the high school GPA cutoff that places a student into the target group is lower for females (3.11) than it is for males (3.43). It should be noted that, although significantly correlated with the criterion (See Table 2.), the quantitative SAT score is not a significant predictor after controlling for gender and high school GPA.

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Classification Accuracy of the Model Based on a Validation Sample

Using the model coefficients based on the analysis sample which are reported in Table 3, predicted probabilities for membership in the target group were calculated for each case in the validation sample. Those cases with probabilities of .5 or better were predicted to be retained with GPA $\geq$ 2.5; those remaining cases were classified into Group 2. (See Table 4.) Sensitivity was 67.0% (as compared to 70.6% in the analysis sample). Specificity was 57.6% (as compared to 66.1% in the analysis sample). The overall percentage of correctly classified cases (*PAC*) using gender and high school GPA as predictors was 62.2% which, as expected, is lower than that (68.3%) of the analysis sample, but does not appear to be appreciably lower. Again, the model does improve the classification accuracy above the base rate *PAC* of 50% which we would obtain without using any predictors (if we assume the probability of being in the target group is 50%, as we found in the analysis sample).

Discussion

The results of this study support other studies which show that high school achievement is the best predictor of success in college (Gose, 1994; Peltier, Laden, & Matranga, 1999; Tinto, 1993, 1998). The findings also complement those of other studies which have found a relationship between gender and persistence (Astin, 1993; Astin, Tsui, & Avalos, 1996; Gallicki & McEwen, 1989; Lewallen,1993; Daly & Breegle, 1989; and York, Bollar, & Schoob, 1993). The results of the current study showed that, for university freshmen who receive assistance in developing basic skills, gender was not a significant predictor of retention. However, once the criterion included earning a first-year GPA $\geq$ 2.5, coupled with retention, gender was a factor.

Although SAT Quantitative score was associated with whether or not a student returned their second year and achieved a GPA $\geq$ 2.5, it was not a significant predictor, after controlling

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for high school GPA and gender. This finding supports the policy being considered by some schools of eliminating the SAT as an admission requirement, due to its lack of prediction (Cloud, 2001; "Sad State of Testing," 2001). The other variables available prior to admission – namely SAT scores – were somewhat predictive in the current study, although not in all areas. However, SAT was not predictive of retention for our sample. Nor was SAT verbal score predictive for our combined outcome of GPA ≥ 2.5 and retention after the first year. Although the SAT Quantitative score was associated with whether or not a student returned their second year and achieved a GPA ≥ 2.5, after controlling for gender and high school GPA, the quantitative SAT was not a significant predictor for our population.

Knowing which of the developmental courses students needed did not improve the accuracy of prediction obtained from use of pre-admission predictor variables. However, this population was diagnosed early (during Orientation and prior to their matriculation), then provided with strong intervention programs. Given that nearly half of our developmental education sample achieved the combined criteria (retention to second year and GPA ≥ 2.5) suggests that students may enter a university under-prepared yet be successful, given appropriate interventions. The university provides a strong centralized developmental program, early student assessment, a strong faculty-referral program through its Office of Retention Services, supplemental instruction, a strong tutoring program, paired courses, course-based reading and writing strategy training, critical thinking instruction, and a well-trained developmental education faculty. The developmental services are available to all students at the university, not just those in its developmental courses. All are practices advocated by leaders in developmental education (Boylan, 1999; Damashek, 1999; and Maxwell, 1997). The literature is replete with evidence that alternative approaches to providing developmental education, such as tutoring,

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individualized learning laboratories, supplemental instruction, paired courses, critical thinking instruction, and strategic thinking instruction benefit the academic needs of the entire student body, and not just target those few who enter below a particular cut-off point (Boylan, Bliss, & Bonham, 1997; Damashek, 1999; Maxwell, 1997).

That the type of developmental education needed was not predictive may suggest (1) all developmental programs (reading, writing, mathematics) at this institution are equally effective (or ineffective) and/or (2) that success depends more upon students' utilization of academic support programs, than their specific skill deficiencies. Adelman's (1996) work suggested that the type of skill deficiency does impact on students' graduation rates; however, we find after just one year in college this trend is not evidenced. Further research, extending through college graduation for the population of developmental education students, needs to be conducted that incorporates the type of developmental skill(s) needed, and, the type and amount of academic resource utilization, in addition to pre-admission information, as predictor variables.

The authors plan to examine the data on this group of students, after allowing for five years for completion of the subjects' undergraduate studies and graduation, to see if number or type of developmental courses taken has any impact on their graduation rates. The examination of the data after graduation will, thus, more closely approximate that of Adelman (1996) and others. We are also interested in examining levels of participation in the university's academic support services to see how well that predicts success (i.e., retention and GPA $\geq$ 2.5) as well as graduation rates.

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Table 1

Descriptive statistics for continuous variables based on the full sample of Developmental Students (N=666)

	Minimum	Maximum	Mean	Std. Deviation
High School GPA	2.12	4.00	3.22	.41
University GPA	.17	3.94	2.56	.66
Verbal SAT scores	230	700	463.41	80.34
Math SAT scores	260	720	503.78	80.87

Table 2

Bivariate Correlations between Individual Predictors and Three Outcomes

		University GPA (N=424)	Whether Retained or Not (N=426)	Whether both Retained and Univ. GPA is 2.5 or better (N=426)
Gender	Pearson Corr.	**.229**	.097	**.191**
	Sig. (1-tailed)	<.001	.023	<.001
High School GPA	Pearson Corr.	**.408**	**.213**	**.360**
	Sig. (1-tailed)	<.001	<.001	<.001
Verbal SAT scores	Pearson Corr.	**.119**	-.089	.069
	Sig. (1-tailed)	.007	.034	.076
Math SAT scores	Pearson Corr.	**.149**	.039	**.119**
	Sig. (1-tailed)	.001	.212	.007
Fail Reading Test	Pearson Corr.	.013	.074	.011
	Sig. (1-tailed)	.392	.064	.412
Fail Writing Test	Pearson Corr.	-.020	.030	-.021
	Sig. (1-tailed)	.339	.266	.333
Fail Math Test	Pearson Corr.	-.040	-.054	-.066
	Sig. (1-tailed)	.204	.135	.087

Note: **Bolded** correlation coefficients are those significant at the 0.01 level (1-tailed). The difference in sample sizes reflects two non-retained students for whom university GPA was unavailable.

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Table 3

Logistic Regression Coefficients and Related Statistics for the Model Based on the Two Significant Predictors of Freshman Retention with GPA = 2.5

	b	*SE*	*Wald*	*p*	*Exp(b)*	*95.0% C.I.for Exp(b)*	
						Lower	Upper
Gender	.610	.210	8.441	.004	1.840	1.220	2.777
High School GPA	1.895	.276	47.283	.000	6.651	3.876	11.415
Constant	-6.507	.905	51.733	.000	.001		

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Table 4

Classification Accuracy Results for the Validation Sample (N = 193) Using the Logistic Regression Model Developed on the Analysis Sample (N = 445)

		Predicted Group Membership		Percentage Correct
		Group 0	Group 1	
Observed Group Membership	Group 0: Not Retained and or university GPA < 2.5	63	31	67.0%
				67.0%
	Group 1: Retained with university GPA ≥ 2.5	42	57	57.6%
Overall Percentage		105	88	62.2%